Theses and Dissertations | 1. Thesis and Dissertation Collection, all items

1993-09

Predicting performance: analysis of background factors and probability of promotion in the surface warfare and submarine officer communities

Saw, Woo Young

Monterey, California. Naval Postgraduate School

http://hdl.handle.net/10945/26706

PREDICTING PERFORMANCE: ANALYSIS OF BACKGROUND FACTORS AND PROBABILITY OF PROMOTION IN THE SURFACE WARFARE AND SUBMARINE OFFICER COMMUNITIES

by

Woo Young Saw
Lieutenant, Korean Navy

Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
September, 1993

REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188

AGENCY USE ONLY (Leave Blank)	2. REPORT DATE September 23, 1993	3. REPORT TYPE AND DATES COVERED

TITLE AND SUBTITLE
PREDICTING PERFORMANCE: ANALYSIS OF BACKGROUND FACTORS AND PROBABILITY OF PROMOTION IN THE SURFACE WARFARE AND SUBMARINE OFFICER COMMUNITIES

5. FUNDING NUMBERS

AUTHOR(S)
Saw, Woo Young

PERFORMING ORGANIZATION NAMES (S) AND ADDRESS(ES)

Naval Postgraduate School
Monterey, CA 93943-5000

8. PERFORMING ORGANIZATION

SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Naval Postgraduate School
Monterey, CA 93943-5000

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited

12b. DISTRIBUTION CODE

ABSTRACT (Maximum 200 words)

This thesis estimates the determinants of promotion probability to Lieutenant Commander over the period 1985-1990 for Surface Warfare Officers (SWOs) and Submarine Officers (SOs). Using data from the Naval Officer Promotion History Data Files, the analysis first examines the frequency distribution of the explanatory variables, then employs a logit regression analysis. The probabilities of promotion are modeled as a function of background factors, which include personal demographics, undergraduate education, and Navy experience. The findings reveal that having a high GPA, a graduate education, more than 3 additional qualification designators (AQDs), and having been screened for command each have a positive effect on promotion for SWOs and are statistically significant. By contrast, being an ROTC graduate, being older, and having a low GPA each have a negative effect on probability of promotion and are statistically significant in the SWO model. In the SO model, having a high GPA, a graduate education, more than 3 AQDs, and a technical undergraduate major are positively significant. Based on the results, it is recommended that the Republic of Korea focus its recruiting efforts on highly qualified officer candidates if it can be demonstrated that the results of this analysis apply to Korea

SUBJECT TERMS Promotion Probability, Recruiting Background Qualifications	16. PRICE CODE
	15. NUMBER OF PAGES 74

SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

N 7540-01-280-5500

Standard Form 298 (Rev 2-89)
Prescribed by ANSI Std 239-18 298-102

ABSTRACT

This thesis estimates the determinants of promotion probability to Lieutenant Commander over the period 1985-1990 for Surface Warfare Officers (SWOs) and Submarine Officers (SOs). Using data from the Naval Officer Promotion History Data Files, the analysis first examines the frequency distribution of the explanatory variables, then employs a logit regression analysis. The probabilities of promotion are modeled as a function of background factors, which include personal demographics, undergraduate education, and Navy experience. The findings reveal that having a high GPA, a graduate education, more than 3 additional qualification designators (AQDs), and having been screened for command each have a positive effect on promotion for SWOs and are statistically significant. By contrast, being an ROTC graduate, being older, and having a low GPA each have a negative effect on probability of promotion and are statistically significant in the SWO model. In the SO model, having a high GPA, a graduate education, more than 3 AQDs, and a technical undergraduate major are positively significant. Based on the results, it is recommended that the Republic of Korea focus its recruiting efforts on highly qualified officer candidates if it can be demonstrated that the results of this analysis apply to Korea

TABLE OF CONTENTS

LIST OF FIGURES

I. INTRODUCTION

As a result of changes in the geo-political environment on the Korean peninsula, the Republic of Korea (ROK) has decided to introduce submarines into its Navy. The highly technical nature of submarine systems and operations will place further demands on a recruiting system that is already hard pressed to compete with other employment options, and serves to emphasize the need for an effective method of identifying individuals who are most likely to develop into capable, and therefore promotable, officers

Far from being limited to submarine communities, the increased dependence of militaries on high technology systems is in part due to a desire for reduction in overall size with a simultaneous increase in effectiveness This means that the armed forces are being asked to do more with less, and the obvious implication is that efforts should be redirected towards increased efficiency. In recruiting practices, this again translates into a need for more accuracy in predicting what background characteristics best indicate officer potential. Where the military once had the luxury of commissioning a large number of recruits in order to select a few for retention and promotion, today's emphasis is on making more select choices in the recruiting stage of the process

This issue is by no means unique to the ROK The US military is and has been engaged in activities designed to increase efficiency in the recruiting and promotion processes Because of the existing research on background characteristics influencing

promotability in the US Navy, and due to the fact that data that specifically describes its submarine community is available, studying the background characteristics of US Navy officer promotion candidates may lead to techniques and conclusions which can be applied in the ROK. It is the purpose of this work to lay the foundation for such an application

A.   BACKGROUND

The task of recruiting high quality personnel is a continuing and highly challenging problem facing the four branches of the Armed Forces of the United States. As the Navy continues to meet reduced officer end strength goals commensurate with the decreasing defense budget, the military recruiter is in direct competition with the civilian business community for these high quality people.

The US military of the twenty-first century will be far different from that of today. Not only will it be smaller in size, but it will be structured in different ways to face new threats and new enemies. Many believe that the reduction in threat from Russia and Warsaw Pact countries is accompanied by an increase in new kinds of threats from other sources. Along with the changing qualifications necessary to deal with the introduction of new types of ships will be the need to develop officers with different backgrounds and experiences to meet these new threats [Ref. 1]

Since World War II, technological advances have greatly affected the US military community, and technically qualified personnel are needed to keep up with these changes.

While technological advances have in some cases redefined the roles of individuals, manpower quality remains the first and foremost determinant of military readiness, because the technology is only useful in that it enables people to accomplish the mission The Navy must continue to attract top quality men and women capable of operating high technology equipment and weapons systems

Recruiting success is highly dependent on the nature of the civilian labor market, the level of military requirements, the quality mix of requirements, the availability of recruiting resources, and competition from civilian employers From an economic perspective, an individual will enlist in the military if the pecuniary and non-pecuniary benefits of enlisting are greater than the "reservation wage," or the benefits of not enlisting People's reservation wages vary depending on their civilian earnings opportunities and their attitudes toward military service Since individuals do not have complete information on all their employment opportunities, people will be more likely to enlist in the military if they are provided information on the benefits of enlisting [Ref 2] During the current force drawdown, manpower planners and recruiters must efficiently use the sparse recruiting resources to target only those people who have the greatest potential for promotion and retention

B.   RESEARCH QUESTIONS

This study will analyze the determinants of promotion for US Navy Surface Warfare and Submarine Officers in terms of their academic backgrounds. The first

research question is: How do graduate education, undergraduate major (technical vs. non-technical), and grade point average (GPA) affect the promotion potential of Submarine Officers (SOs) and Surface Warfare Officers (SWOs)? The second research question is: How can these results be applied to the recruiting policy for ROK Navy SOs and SWOs? While this thesis is not intended to be a commissioning source optimization study or a cost-benefit analysis, it will offer indications as to the background factors involved in the development of successful officers and enable individuals and organizations to identify which of those background characteristics play significant roles.

C. SCOPE, LIMITATION, AND ASSUMPTIONS

It can be inferred from an intuitive analysis of promotion prediction theory that job performance and job assignment are the most important factors contributing to selection or non-selection to the next higher rank. Simply stated, these factors are the principal items that are measured on officer fitness reports, therefore, if one is a proven performer, he/she is selected for the best job. Good performance at the best job leads to increased or accelerated promotion, and consequently assignments with greater responsibility later in the career. For Surface Warfare and Submarine Officers, the best billets are at sea, and if an officer wants to remain competitive with his/her peers, he/she should not spend too much time in shore-billets, regardless of how tasking the shore assignment is.

This study is relevant in that it attempts to look beyond officer productivity and carefully examine the background characteristics mentioned previously as predictive

4

elements to performance. The reasoning behind such an analysis is that prior to commissioning, officers face many different challenges in reaching their ultimate goal of an undergraduate degree; and these factors may correlate to these officers' performance in the Navy.

The SWO and SO communities are the subjects of this research effort. Officers who are graduates of the USNA, ROTC, and OCS are included in the sample analyzed. The data set used in this study includes the entire population of officers going before the Lieutenant Commander (O-4) (1985-90) selection boards, with the exception of those officers who have incomplete data records or who had left the service due to death or disability. Also, due to the fact that there were relatively few female SWOs and no SOs in the population, female officers are not included in this study.

D. ORGANIZATION

This study is organized into five chapters. Following the introduction and background contained in Chapter I, Chapter II reviews previous studies and literature related to this area of research. Chapter III describes the data files that are employed in this study. A detailed explanation of the model specification and a description of variables is also provided. Chapter IV presents the empirical results of this study using bivariate and multivariate analysis. Chapter V offers conclusions and recommendations based on the results of the empirical analysis, and is divided into two parts. The first discusses the results in terms of the US Navy; the second seeks to determine the

5

implications of the analysis for the ROK Navy and offer suggestions on how to carry out

and make use of such a study in recruiting practices

II. PREVIOUS STUDIES OF PROMOTION FACTORS

A.   THE "RICKOVER HYPOTHESIS"

William R Bowman tested the hypothesis that the best naval officers who graduate from the Naval Academy are those who have a technical undergraduate major [Ref 3] He called this argument the "Rickover Hypothesis" because this belief was strongly held by Admiral Hyman Rickover, the father of the nuclear navy The major objective of Bowman's study was to model the statistical relationship between an individual's performance at the Naval Academy and his later performance as a junior officer in the fleet [Ref 3] He modeled the retention probability, defined as the probability that an officer will remain at least six months beyond his initial length of obligated service He also examined the long-standing controversy concerning how best to prepare college graduates to become successful leaders and managers in the military Bowman studied USNA graduates commissioned from 1976 through 1980 who entered the SWO and SO communities. He merged personal demographic and Navy experience data from the Defense Manpower Data Center's (DMDC) 1986 Navy Officer Master/Loss Files and from a longitudinal profile of officer fitness reports (from entry into active duty through fourth quarter 1986) developed by the Navy Personnel Research and Development Center (NPRDC). He used a regression model to explain differences in the officer selection process between the surface and submarine communities, then ran separate Logit models

of performance and retention for both communities. The results showed a very weak statistical relationship between USNA major and fleet performance, as measured by fitness reports and other factors related to ship type and job performance variables. His findings suggest that junior officer performance evaluations measure managerial more than leadership skills. Also, he argued that the need for technical expertise diminishes as officers advance to positions requiring greater managerial and administrative skills [Ref. 3]. As for retention probability, he found that retention decisions are based on personal characteristics, the quality of work experience encountered during one's first tour, and perceived monetary options near the end of one's obligation -- not on academic background in college. Thus, Bowman's study did not support the "Rickover Hypothesis" [Ref. 3].

Bowman's study focused only on USNA graduates. This may limit the ability to apply these results to a wider population of Navy officers. A possible alternative would have been to compare Naval Academy graduates to NROTC graduates, or NROTC engineers to NROTC non-engineers.

B.   COMMISSIONING SOURCE

In another study that dealt with officer performance, Bowman chose the SWO and pilot officer communities [Ref. 4]. By analyzing retention and promotion, he tried to quantify the "returns on investment" from each commissioning source. The data set he used, Officer Promotion History Data File (OPHDF), contained Navy Officer

Master/Loss File information at the time of the promotion boards. This data set will be discussed in Chapter III. Bowman found that in the Surface Warfare community "more selective" college graduate officers are more likely to leave the service voluntarily. However, if they remain in the Navy, they have higher promotion rates. He supports the findings that USNA graduates provide greater returns on investments in undergraduate education compared to officers from other commissioning sources. Naval Academy graduates are less likely to leave the service and more likely to be promoted in-zone at the O-4 selection boards as compared to other commissioning sources [Ref 3].

Michael J Foster compared the relative productivity of officers with different commissioning sources based on fitness report data [Ref 5]. He sampled data on 15,365 Surface Warfare Officers and Submarine Officers over the period 1977 to 1987. Foster demonstrated that Naval Academy graduates outperformed ROTC and OCS graduates by a small margin

C.   GRADUATE EDUCATION

In his study, Donald J Cymrot assessed the benefit to the Navy of providing graduate education to its officers [Ref 6]. He wanted to develop a theoretical and empirical technique for determining the size of the benefit to the Navy of having officers with advanced degrees. To do this, he examined the effect of graduate education on promotion (used as a measure of productivity). Cymrot determined the optimal level of graduate education by measuring the marginal benefit and marginal cost of graduate

education to the Navy. He also estimated that a portion of the marginal benefit may be attributed to an increase in promotion rates. He assumed that there exists a relationship between graduate education and officer productivity; that is, officers get promoted because they are relatively more productive than their peers. The Navy selects only those officers for graduate education who are considered promotable. For this study, a Logit model that estimates the probability of promotion to the next rank within a given period of time was used to establish the effect of graduate education on officer productivity. The cross-sectional data was taken from the Officer Master File, March 1985, and the model eliminated anyone who had already left the service. Selection bias affected the empirical results because promotability is one of the criteria used to select an officer for graduate education. Cymrot attempted to compensate for this by including two variables for previous experience and job performance. However, some weaknesses were found in this study. Rather than using a cross-sectional data set, it would have been preferable to use a data set that tracks year-group cohorts. This would account for those officers who left the service, either through self-selection or convenience of the government. Secondly, marginal benefits are measured as differences in productivity between officers of the same rank but with different years of total service. A more accurate measure of benefits might have been obtained by looking at differences between a particular rank and the subsequent rank. Another weakness in his study is that there is no way to account for the yearly promotion rates. Cymrot's model assumes the same promotion rate each year, when in reality, these rates change. Cymrot's study found that graduate education has a

10

significantly positive effect on the promotion probability up to and including the rank of Captain

D.   MULTIPLE FACTORS

Joseph F. Nolan's work examines "educational and training (human capital) investment made by the individual and the organization, and models the individual and cumulative impact of such investments on officer performance" [Ref 7] Nolan obtained his data set from the Naval Officer Promotion History Data Files, which contain information on officer background, Navy experience, selection board results, and separation data   The second data set was from the Naval Personnel Research and Development Center's Traintrack System Files, which enabled him to add Navy training information to the basic data set   He merged these files to facilitate research efforts in his study of the Surface Warfare Officer community. In his study, Nolan estimated 3 models. Retention between O-3 and O-4 selection boards, early professional qualification, and promotion to O-4   In his models he defines measures of effectiveness (MOE) as investments made by both the individual and the organization in education and training, and models the impacts of these human capital investments on officer performance   In all of his models except the retention model, Nolan found a positive correlation between MOE attainment and department head school attendance, qualifications resulting from on-the-job training (engineering officer of the watch and officer of the deck (underway)), selective undergraduate colleges, and having greater likelihood of higher educational

11

quality and costs. Nolan concluded his study by stating that, in considering the future impact of budget reductions in the area of Navy training, the impact on MOE attainment may be felt the most by graduates of the medium and less selective colleges. For these officers, training investments are statistically important in explaining their MOE attainment [Ref 7].

E.   RELEVANCE

The studies reviewed here have demonstrated a couple of methodologies for determining officer performance This study does not explore a new and improved methodology for examining the educational effect on promotion, but analyzes the determinants of promotion, primarily academic background, in both the SWO and SO communities

III. CONSTRUCTION OF PROBABILITY MODEL

Promotion to the rank of Lieutenant Commander (O-4) almost guarantees a Naval Officer that he/she can serve his/her country for twenty years and retire a career Naval Officer. Work by Bowman and Cymrot laid the foundation used in this analysis.

A.   DATA SOURCES

The data files used for this statistical analysis were obtained from Bowman's Naval Officer Promotion History Data Files, which were derived from the Navy Officer Master Files, and from the Navy Officer Loss Files, which he had previously compiled through earlier research. Data from the O-4 (1985 to 1990) selection boards provides "career snapshots of an individual at the time of the board commencement" [Ref 7] The data set is the population of officers that was reviewed by the selection boards, except for those personnel who had incomplete data records or who had separated from the Navy for death or medical disabilities. Only USNA, ROTC, and OCS graduates were included in this study. ROTC scholarship program graduates and ROTC contract (or college) program students were analyzed as a group because both count towards fulfilling the quota of graduates from a particular ROTC unit Nuclear power trained officers were included within the general data set because no variables were available to identify them separately.   Due to the small number of female SWOs in the sample (37) and the

complete absence of females in the SO community, only males were used. The resulting data set for the SWO community included 1700 observations; 749 for the SO community.

B.   MODEL DESCRIPTIONS

1. Dependent Variable

The dependent variable is the performance of officers at the LCDR promotion board. The dependent variable, PROMOTES, does not include officers who were passed over at one board and promoted at another because such a historically low percentage (5%) of officers get selected after being passed over. PROMOTES encompasses the promotion board categories as shown in Figure 1

PROMOTION CATEGORY

1. SELECTED BELOW ZONE (EARLY)

2. SELECTED IN-ZONE

3. PASSED OVER IN-ZONE

4. SELECTED ABOVE ZONE (LATE)

5. PASSED OVER ABOVE ZONE
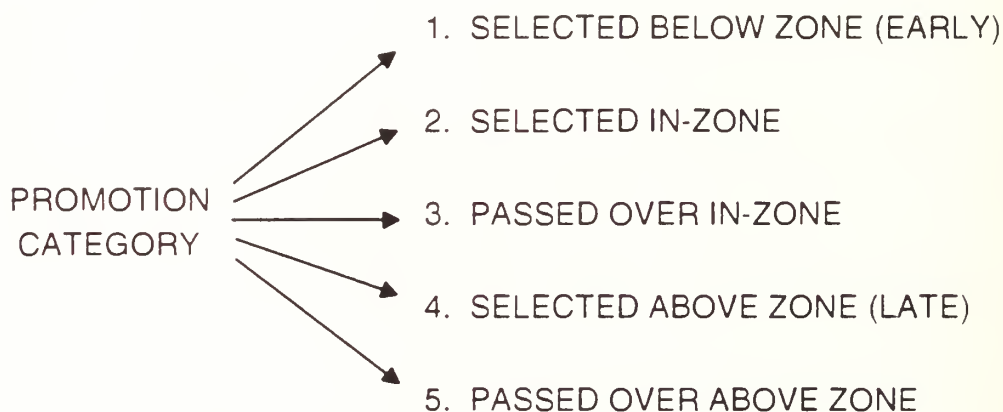
Figure 1. Promotion Categories in Data Set.

For the purpose of this study, candidates in categories (4) and (5) above were deleted from the data set and not used. In the logistic model, PROMOTES = 0 if selected early or in-zone and 1 if passed over. The dependent variable, therefore, is a binary variable that places officers into one of two categories: promoted or passed over. A Logit analysis is used to estimate the model's coefficients because this method avoids the unboundedness problem inherent in ordinary least square (OLS) computations when working with dummy dependent variables.

2. Independent Variables

Figure 2 shows the groups of background factors and the variables associated with the promotion model.

a. Personal Demographics

The first category concerns personal demographics. WHITE is a binary variable signifying an individual's status as either a minority (black and other categories) or white. Bowman showed in his study that minority officers have lower promotion rates [Ref. 3], and the *a priori* assumption in this study will coincide with his analysis. WHITE equals 1 for white promotion candidates and 0 for non-white candidates. The variable MARRIED WITH AT LEAST TWO CHILDREN equals 1 if the condition is satisfied, 0 otherwise. AGE AT PROMOTION is a continuous variable. The COMMISSIONING SOURCE variable identifies the individual's accession program.

15

```
┌─────────────────────────────────────────┐
│ ┌───────────────────────────────────────┤
│ │ Personal Demographics                 │
│ │ RACE/ETHNIC GROUP                     │
│ │ DEPENDENTS                            │
│ │ AGE AT PROMOTION                      │
│ │ COMMISSIONING SOURCE                  │
┌─┤ └─────────────────────────────────────┤
│ │ Academic Background                   │
│ │ MAJOR                                 │
│ │ GPA                                   │
│ │ COLLEGE SELECTIVITY                   │
│ │ ACADEMIC PROFILE CODE (TQC, MQC)      │
┌─┤ GRADUATE EDUCATION                    │
│ └───────────────────────────────────────┤
│ Navy Experience                         │
│ ADDITIONAL QUALIFICATION DESIGNATOR (AQD)│
│ COMMANDER SCREEN                         │
└─────────────────────────────────────────┘
```

Figure 2. Categories and Variables for Promotion Model.

b. Academic Background

The second group of background factors contains information on the individual's academic background

The grade point average (GPA) was broken down into 3 additional variables:

- **HIGH**   **(3.2 - 4.0)**

- **MEDIUM**   **(2.2 - 3.19)**

- **LOW**   **(less than 2.2)**

16

MEDIUM, which accounted for 1,311 observations, was used as the omitted condition. The expectation is that the higher the academic performance, which may derive from ability, effort, persistence, etc., the better the performance on active duty, and the better the promotion rate.

The categories of college selectivity used in this study are based on *Barron's Profiles of American Colleges* [Ref 8]. Barron's criteria for determining the selectivity category for each college included

- Median entrance examination scores for recent freshman class (SAT/ACT)
- Percentage of freshman class scoring above a designated SAT/ACT score
- Percentage of incoming freshman class ranked in the upper fifth and upper two fifths of high school class
- College admission policy on minimum standards for grade point average and class rank
- Percentage of recent freshman class applicants actually accepted

In this analysis the HIGH college selectivity category, representing Barron's "Most Competitive" and "Highly Competitive" categories, includes the US Naval Academy and such schools as Stanford and the members of the Ivy League. The MEDIUM college selectivity category, representing Barron's "Very Competitive" category, is composed of private and public schools that are not as selective as the first category. Lastly, the LESS selective category, representing Barron's "Competitive" and

"Less Competitive" categories, contains many public schools and small private colleges, some of which have special educational missions [Ref. 8].

This study uses Academic Profile Codes (APCs) to differentiate between engineering majors and non-engineering majors   The APC is a three-digit code that summarizes portions of an individual's undergraduate academic performance. In addition to the GPA, other areas of academics are quantified   The Mathematical Qualification Code (MQC) reflects academic background and performance in calculus-related mathematics courses   The Technical Qualification Code (TQC) measures performance in science or engineering courses   In this study, HIGH MATHEMATICAL CODE signifies an individual with significant post-calculus math with grades of B or higher or completion of a calculus course sequence with B+ average or higher. Similarly, HIGH TECHNICAL QUALIFICATION CODE indicates pertinent upper-division technical courses with an average of B+ or higher, or signifies a physics sequential course with a B+ average or higher   Graduate education included in the second category allows a reexamination of Cymrot's conclusion that a master's degree has a positive effect on promotion probability, up to and including the rank of Captain

c. Navy Experience

The third group of background factors deals with an individual's Navy experience   Since promotion to higher rank is based on performance, and the data set did not contain any information relevant to past performance, such as might be gleaned from fitness reports, this thesis uses the variables COMMANDER SCREEN, to indicate if the

18

candidate has been screened for command, and MORE THAN 3 AQDs, to reflect more
than three additional qualification designators (AQD).

C.   MODEL SPECIFICATION

The promotion likelihood relationship is specified using a Logit model, with the
dependent variable equal to 1 if selected for promotion and 0 if not selected for
promotion. An initial specification of the models and predicted signs of the coefficients
for both SWOs and SOs appears in Figure 3


```
                          ┌─                                                         ─┐
                            {+} HIGH GPA and HIGHLY SELECTIVE COLLEGE
                            {+} WHITE
                            {+} USNA
                            {+} ROTC
                            {-} OCS
                            {+} LOW GPA and LOW SELECTIVE COLLEGE
                            {+} HIGH MATHMATICAL CODE
                            {+} HIGH TECHNICAL QUALIFICATION CODE
                            {+} MORE THAN 3 ADQs
  ┌─────────────┐           {+} AGE AT PROMOTION
  │ PROMOTION   │ =f        {+} NUMBER OF YEARS OF ACTIVE DUTY SERVICE
  │ LIKELIHOOD  │           {+} TECHNICAL UNDERGRADUATE MAJOR
  └─────────────┘           {+} HIGH GPA
                            {+} LOW GPA
                            {+} MARRIED AND AT LEAST TWO CHILDREN
                            {+} MASTERS DEGREE
                            {+} HIGHLY SELECTIVE  COLLEGE GRADUATE
                            {+} SCREENED FOR COMMAND
                            {+} LOW SELECTIVE COLLEGE GRADUATE
                            {+} MASTERS AWARDED FROM NPS
                            {+} MASTERS AWARDED FROM OTHER INSTITUTION
                          └─                                                         ─┘
```

Figure 3. Initial Specification of Promotion Likelihood Model.

A detailed description of the variables is provided in Appendix A for both officer communities   In the Submarine Officers promotion model, only white officers are included, due to the small number of minority officers in the population (18 out of 749). Also, because of the strict entry requirements for Submarine Officers, the LOW GPA variable was excluded   Appendix B summarizes the officer recruit qualifications for the SO community

IV. EMPIRICAL ANALYSIS OF MODELING RESULTS

A. DATA ANALYSIS

1. Surface Warfare Officer Community

The bivariate analysis of the data for SWOs contains an examination of the frequency distribution of the explanatory variables used in the promotion Logit model. Pie-charts of distribution and bar graphs of promotion probability provide insight into the nature of the data

a. Distribution

Figures 4 shows the distribution of SWO promotion candidates among three commissioning sources: USNA, OCS, and ROTC. There is a fairly even distribution of sample candidates from the three source groups
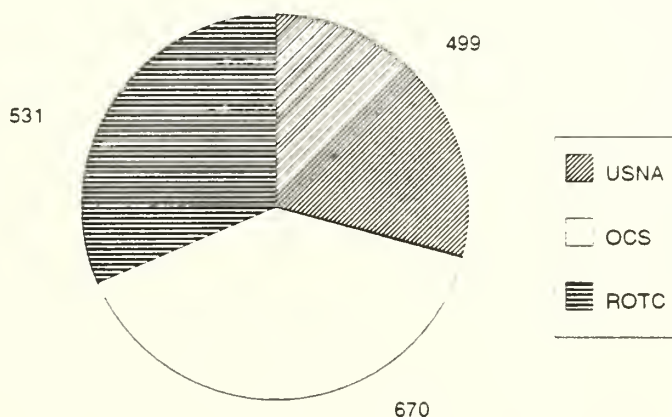
Figure 4. Number of Promotion Candidate SWOs by Commissioning Source.

Figure 5 differentiates among the SWO sample group by GPA category. The overwhelming majority of promotion candidates fall into the middle category, with a generally even division of the remainder between high and low GPAs.
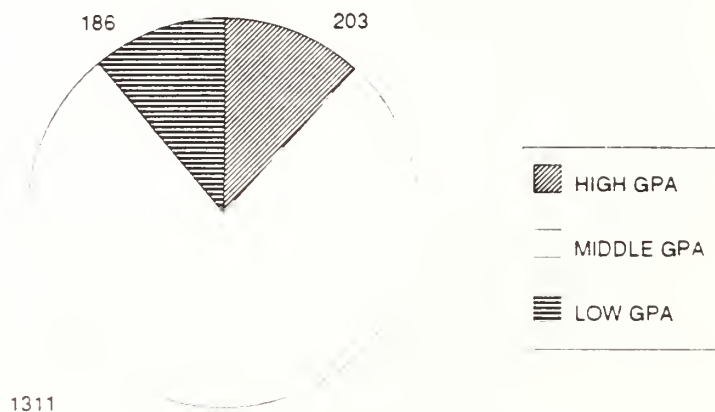
Figure 5. Number of Promotion Candidate SWOs by GPA Category.

Figure 6 describes the SWO sample in terms of the level of selectivity of the promotion candidates' undergraduate school. The majority of candidates come from schools in the middle selectivity category. Candidates from schools that are in the low selectivity category are in the minority.
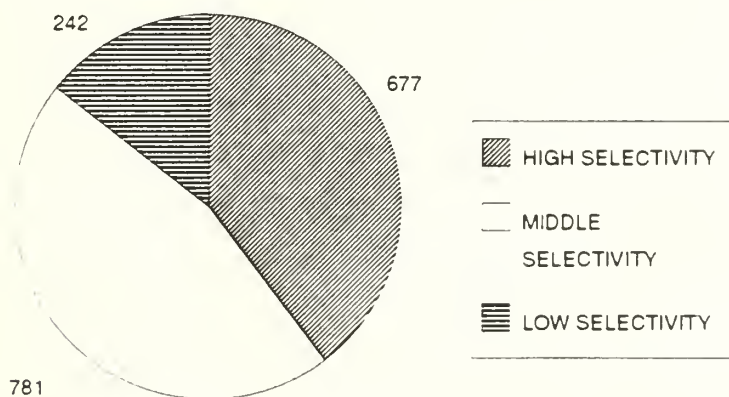
Figure 6. Number of Promotion Candidate SWOs by Undergraduate College Selectivity.

As shown in Figure 7, more than three-quarters of the SWO candidates at the

O-4 selection boards had not obtained a master's degree
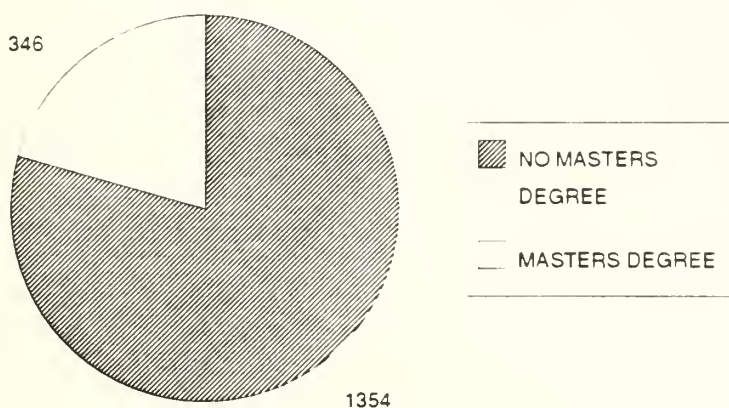
Figure 7. Number of Promotion Candidate SWOs by Graduate Education.

Among those SWOs with a master's degree, Figure 8 shows the distribution of candidates with master's degrees from the Naval Postgraduate School, as opposed to other graduate institutions.
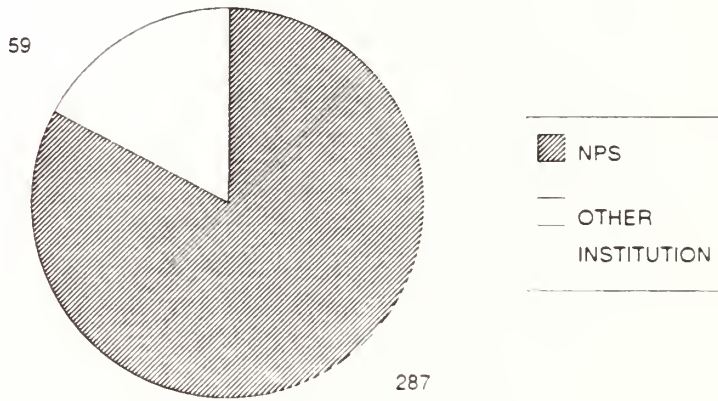
Figure 8. Number of Promotion Candidate SWOs by Attendance at NPS.

Finally, Figure 9 shows the number of SWO promotion candidates with a technical undergraduate major and the number of candidates with majors other than technical Non-technical undergraduate degree recipients make up almost three-fourths of the sample set

489

NON-TECHNICAL

TECHNICAL

1211
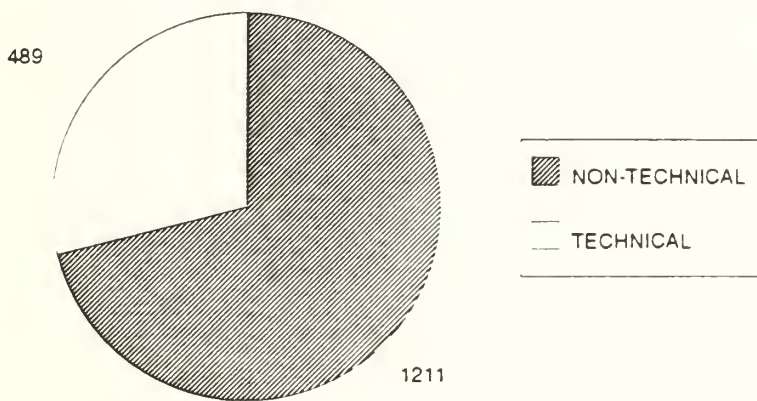
Figure 9. Number of Promotion Candidate SWOs by Technical/Non-Technical Undergraduate Major.

b. Promotion Rates

Figure 10 illustrates the promotion rate for each SWO background variable group. In other words, the rate of promotion for members of a specific background group, independent of other background characteristics, is listed. USNA's 83 percent promotion rate exceeds OCS at 74.9 percent and ROTC at 75 percent. One should also note that the High GPA graduates' 86.7 percent exceeds the Middle GPA group at 77.4 percent and the Low GPA group at 66.7 percent. The O-4 promotion rate is 10.7 percentage points higher for graduates of highly selective schools, as compared to graduates of schools with low selectivity.
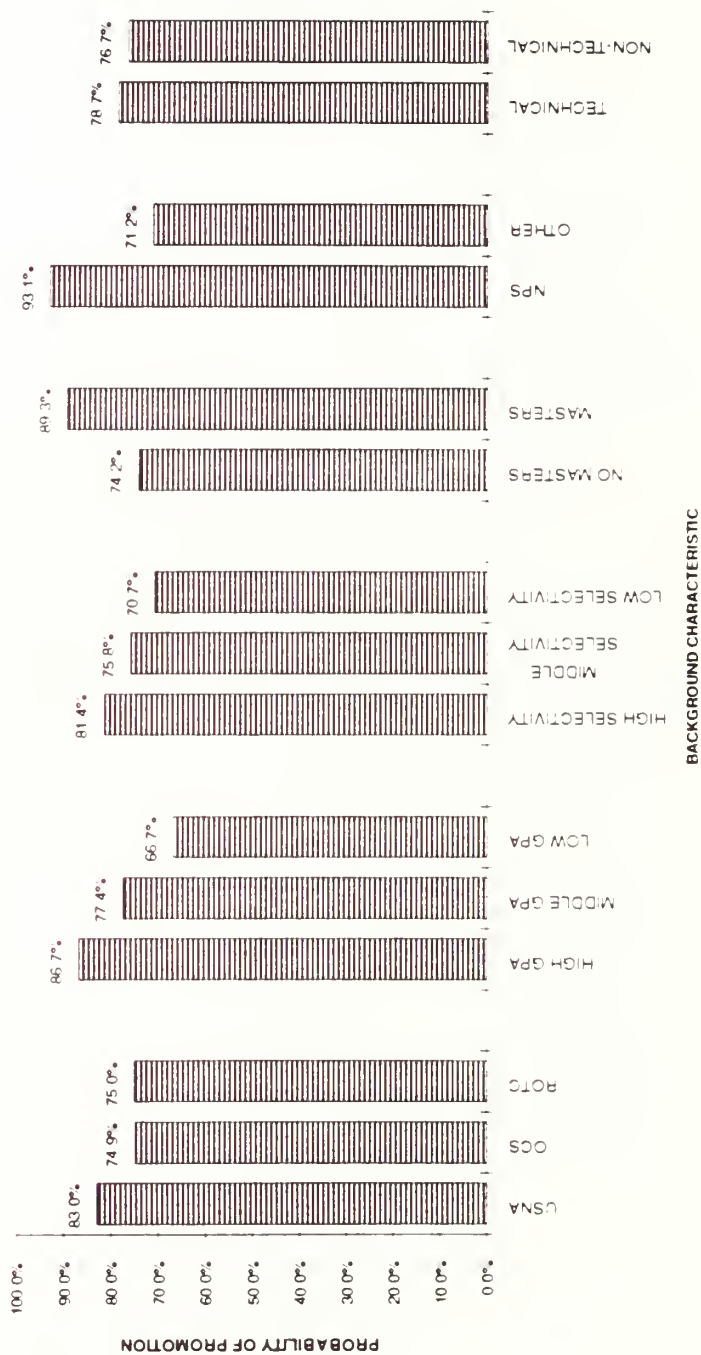
Figure 10. Promotion Rates for SWOs by Background Characteristics.

26

For graduate education, the bar graph illustrates that those who have master's degrees have an 89.3 percent promotion rate, which exceeds the 74.2 percent rate for those without master's degrees. The category can be further investigated by separating it into Naval Postgraduate School alumni and those of other graduate institutions. Those who graduated from the NPS have a selection rate 21.9 percentage points higher than those from other graduate institutions. It also can be seen that an undergraduate technical major is not, on average, associated with an increased O-4 promotion rate. The technical group rate is only two percentage points higher than the non-technical group rate.

Table I displays the description of the variables and their means for the SWO promotion model. The majority of SWOs in this sample are white male graduates from either ROTC or OCS. Over 74 percent of the total sample of promotion candidates were promoted. A review of possible individual quality indicators shows that approximately 12 percent had high GPAs and approximately 40 percent had attended a highly selective undergraduate institution. The other reliable indicators of expertise and prior success are represented by the 55 percent who had more than 3 AQDs and approximately 22 percent who had screened for command. Of those 20 percent who had a master's degree, 83 percent of the officers were granted a master's degree from the Naval Postgraduate School, and the rest were granted from different institutions. For the undergraduate majors roughly 29 percent had obtained technical degrees.

TABLE I. DESCRIPTIVE STATISTICS FOR VARIABLES IN
SWO PROMOTION MODEL

EXPLANATORY VARIABLES	MEAN (STANDARD DEVIATION)
WHITE	0.911 (0.716)
USNA GRADUATE	0.294 (0.455)
ROTC GRADUATE	0.312 (0.464)
OCS GRADUATE	0.394 (0.489)
HIGHLY SELECTIVE COLLEGE	0.398 (0.489)
LOW SELECTIVE COLLEGE	0.142 (0.349)
MASTER'S AWARDED FROM NPS	0.169 (0.375)
MASTER'S AWARDED FROM OTHER INSTITUTION	0.034 (0.183)
MORE THAN 3 AQDs	0.553 (0.497)
SCREENED FOR COMMAND	0.218 (0.413)
AGE AT PROMOTION (IN YEARS)	32.250 (2.620)
NUMBER OF YEARS OF ACTIVE DUTY SERVICE	8.991 (0.441)
TECHNICAL UNDERGRADUATE MAJOR	0.287 (0.453)
HIGH GPA (3.2-4.0)	0.119 (0.324)
LOW GPA (0-2.19)	0.109 (0.312)
MARRIED AND AT LEAST TWO DEPENDENTS	0.768 (0.422)
MASTER'S DEGREE	0.203 (0.402)
HIGH GPA AND HIGHLY SELECTIVE COLLEGE	0.053 (0.225)
LOW GPA AND LOW SELECTIVE COLLEGE	0.010 (0.102)
HIGH TECHNICAL QUALIFICATION CODE	0.085 (0.280)
HIGH MATH QUALIFICATION CODE	0.114 (0.318)

*ALL VARIABLES IN PERCENT EXCEPT AGE AT PROMOTION NUMBER OF YEARS OF ACTIVE DUTY SERVICE

2. Submarine Officer Community

a. Distribution

28

Figure 11 shows the distribution of SO community promotion candidates among the three commissioning sources. Almost half of the candidates were commissioned from the USNA, and ROTC graduate candidates accounted for more than half of the remainder, leaving OCS graduate officers in the minority
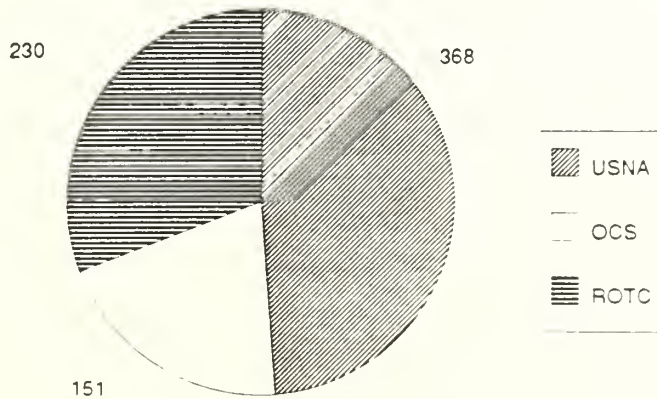
Figure 11. Number of Promotion Candidate SOs by Commissioning Source.

Figure 12 illustrates the division of the SO sample for those with high, middle, and low grade point averages. More than half of the candidates are in the Middle GPA category, and the Low GPA group accounts for only four out of the sample of 749

29

4

335

410

▨ HIGH GPA

— MIDDLE GPA

☰ LOW GPA
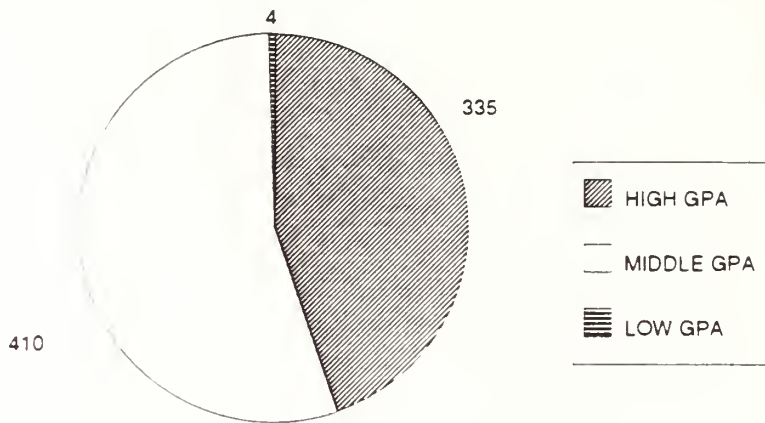
Figure 12.   Number of Promotion Candidate SOs by GPA.

Figure 13 indicates selectivity among the undergraduate institutions attended by the SO sample group   Approximately two-thirds of the promotion candidates were in the High Selectivity category, and those with educations from the Low Selectivity category schools accounted for less than ten percent of the group

59

463

227

▨ HIGH SELECTIVITY

— MIDDLE
   SELECTIVITY
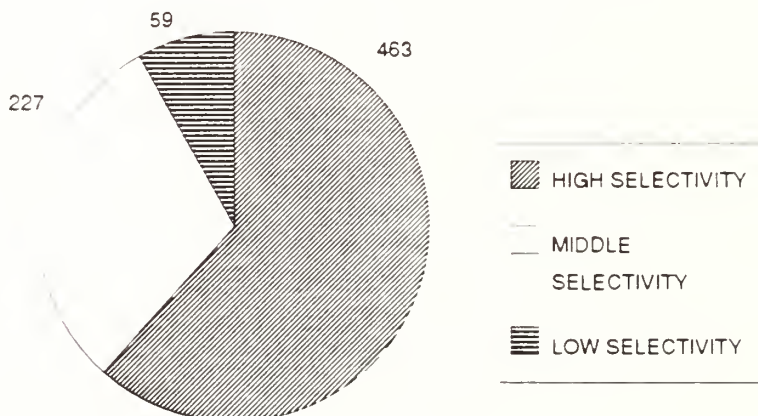
☰ LOW SELECTIVITY

Figure 13.   Number of Promotion Candidate SOs by Undergraduate College Selectivity.

30

Figure 14 shows the division of the SO sample based on whether or not the candidate possesses a master's degree. Only about one-eighth of the data sample possess a master's degree.
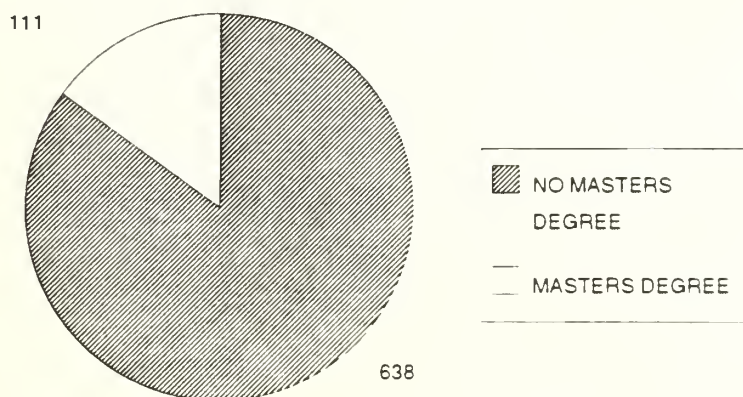
Figure 14.   Number of Promotion Candidate SOs by Graduate Education.

Among those who have master's degrees, Figure 15 differentiates between those SOs who received their graduate education at the Naval Postgraduate School and those who attended other institutions. Nearly one-third of the graduate-educated candidates were awarded a master's degree at the NPS

Figure 16 shows the number of SO promotion candidates who received technical undergraduate degrees, as opposed to those who had non-technical undergraduate majors. Approximately two-thirds of the promotion candidates had technical degrees.
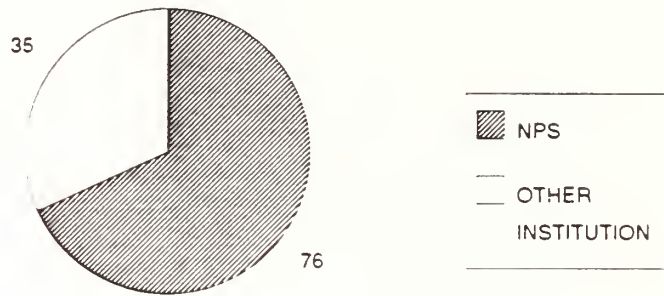
Figure 15. Number of Promotion Candidate SOs by NPS Attendees and Others.
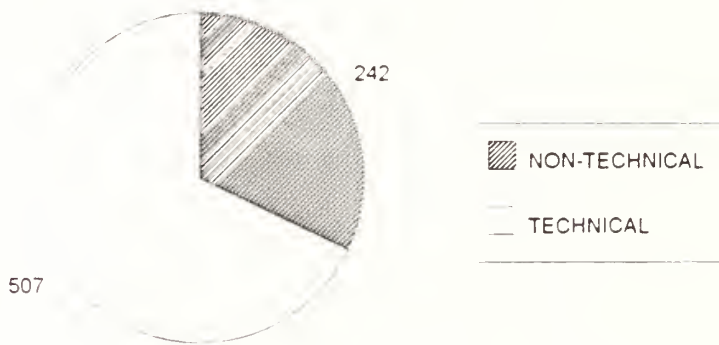
Figure 16. Number of Promotion Candidate SOs by Technical versus Non-Technical Undergraduate Degree.

b. Promotion Rates

32

Figure 17 lists the promotion rates for the SO community by background group. There seems to be a noticeable promotion differential in the Submarine Officer community. USNA's 86.8 percent promotion rate exceeds OCS at 76.8 percent and ROTC at 80.0 percent. Highly selective college graduates have promotion rates that are 9.3 and 6.3 percentage points higher, as compared to middle and low selective college graduates, respectively. The High GPA graduates' 89.3 percent promotion rate also exceeded the Middle GPA group's 78 0 percent promotion rate. For graduate education, those who have a master's degree have an 88 3 percent promotion rate, which is 6 6 percentage points higher than those who do not have a master's degree. Of those who have master's degrees, 68 5 percent received them from the NPS, and their promotion rate was approximately 3 8 points higher than the rate for those who received degrees from other graduate institutions. An additional perspective from Figure 17 is the fact that technical undergraduate major has a minimal effect on the O-4 promotion rate. It exceeds the rate for non-technical majors by only 2 4 percentage points. Descriptive statistics and explanations of the variables in the Submarine community promotion model are found in Table II
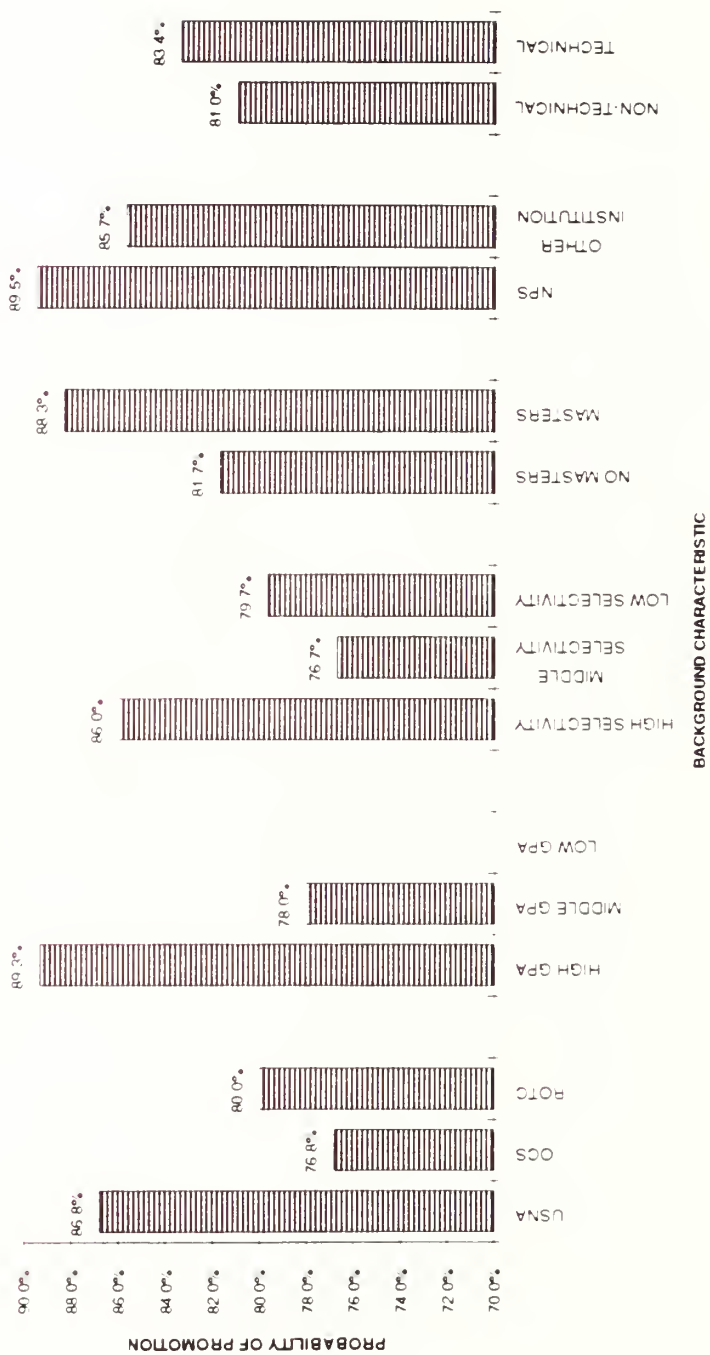
Figure 17. Promotion Rates for SOs by Background Characteristics.

34

TABLE II. DESCRIPTIVE STATISTICS FOR VARIABLES IN SUBMARINE COMMUNITY

EXPLANATORY VARIABLES	MEAN (STANDARD DEVIATION)
WHITE	0.976 (0.847)
USNA GRADUATE	0.491 (0.500)
ROTC GRADUATE	0.307 (0.461)
OCS GRADUATE	0.201 (0.401)
HIGHLY SELECTIVE COLLEGE	0.618 (0.486)
LOW SELECTIVE COLLEGE	0.078 (0.269)
MASTER'S AWARDED FROM NPS	0.101 (0.302)
MASTER'S AWARDED FROM OTHER INSTITUTION	0.046 (0.211)
MORE THAN 3 AQDs	0.586 (0.493)
SCREENED FOR COMMAND	0.049 (0.216)
AGE AT PROMOTION (IN YEARS)	31.073 (1.491)
NUMBER OF YEARS OF ACTIVE DUTY SERVICE	8.984 (0.354)
TECHNICAL UNDERGRADUATE MAJOR	0.676 (0.467)
HIGH GPA (3.2-4.0)	0.447 (0.497)
LOW GPA (0-2.19)	0.005 (0.072)
MARRIED AND AT LEAST TWO DEPENDENTS	0.814 (0.389)
MASTER'S DEGREE	0.148 (0.355)
HIGH GPA AND HIGHLY SELECTIVE COLLEGE	0.263 (0.440)
LOW GPA AND LOW SELECTIVE COLLEGE	0.001 (0.036)
HIGH TECHNICAL QUALIFICATION CODE	0.510 (0.500)
HIGH MATH QUALIFICATION CODE	0.558 (0.496)

* ALL VARIABLES IN PERCENT EXCEPT AGE AT PROMOTION NUMBER OF YEARS OF ACTIVE DUTY SERVICE.

In Table II the descriptive statistics show that the sample group remains primarily white USNA graduates The percentage of those with high GPAs in the Submarine community was approximately 4 times that of the SWO community About 62 percent attended a highly selective college Viewing Table II from a different perspective, 26 percent of the Submarine officers in O-4 selection boards had high GPAs and attended highly selective colleges. Another distinctive aspect of the Submarine community is the fact that approximately 51 percent of the officers had high TQC's and 67 percent had an

undergraduate technical major. As compared to SWO officers, Table II indicates that Submarine officers account for 6 times as many high technical codes and 2 4 times as many technical undergraduate majors. Finally, more than half have more than three AQDs.

3. Academic Background In The Submarine Officer Community

a. Technical Undergraduate Degree

In Figure 18, which shows SO promotion candidates with undergraduate technical majors by commissioning source and GPA, more than half of the total promotion candidate sample is in the Middle GPA category. A little over half of the High GPA group were commissioned from the USNA, and OCS graduates make up a smaller share of the remainder than do ROTC graduates. The majority of the Middle GPA group is made up of USNA graduates, with OCS graduates again having the smallest representation. There was only one observation in the Low GPA category.

b. Non-Technical Degree

By contrast, Figure 19 illustrates that more than half of the SO promotion candidates with non-technical undergraduate degrees are in the high GPA category. USNA and OCS are the primary commissioning sources, with ROTC graduates making up about 15 percent of the High GPA group.

High GPA: TOTAL 207

	USNA
	OCS
	ROTC

61
105
41
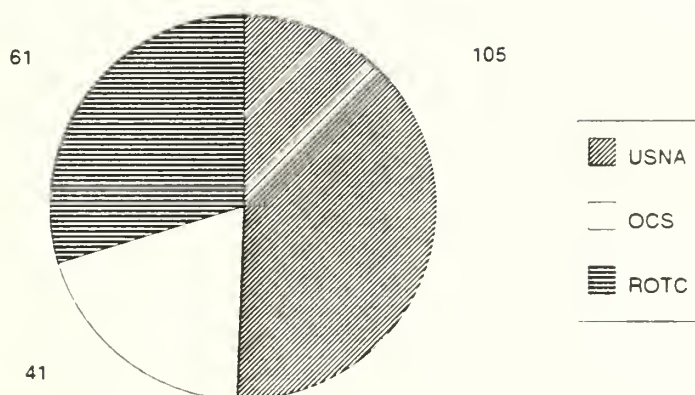
MIDDLE GPA: TOTAL 299

	USNA
	OCS
	ROTC

122
148
29
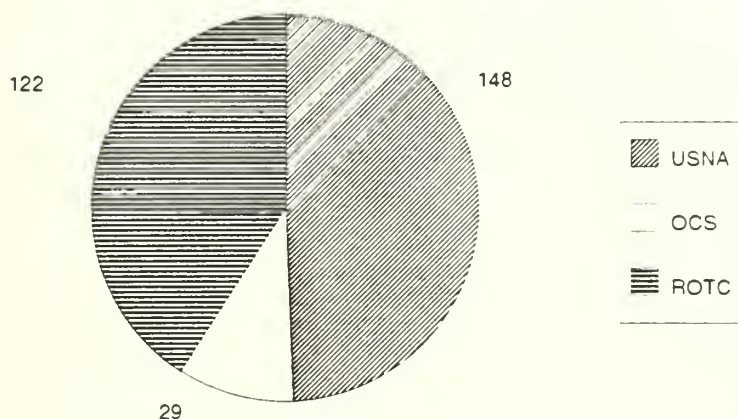
LOW GPA
ROTC: 1

Figure 18. SO Community Promotion Candidates with Technical Undergraduate Degrees by GPA Category and Commissioning Source.

High GPA: TOTAL 128

20
59
49
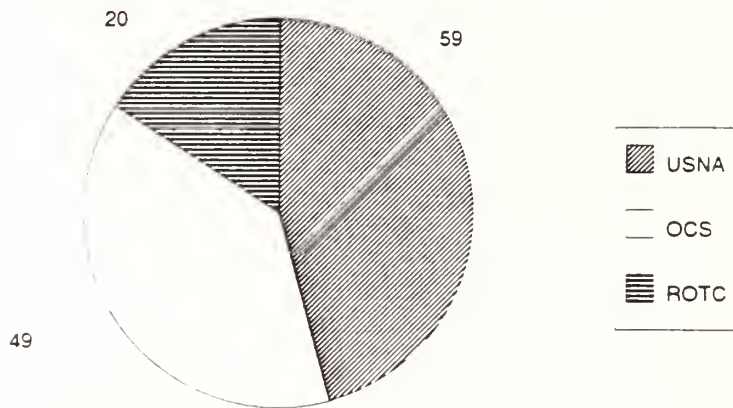
USNA
OCS
ROTC

MIDDLE GPA: TOTAL 111

26
55
30
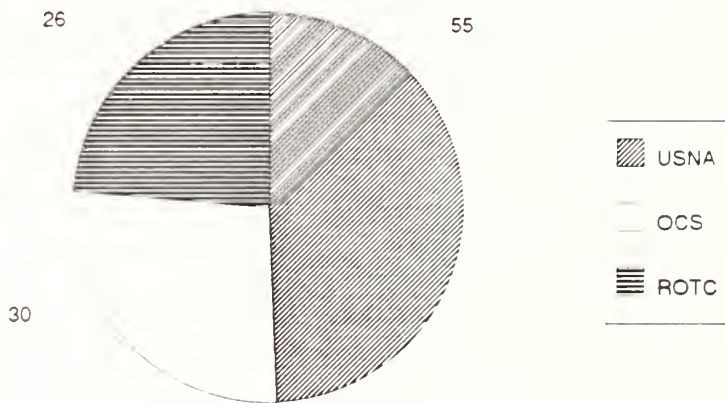
USNA
OCS
ROTC

LOW GPA
USNA: 1
OCS: 2

Figure 19. SO Community Promotion Candidates with Non-Technical Undergraduate Degrees by GPA Category and Commissioning Source.

38

USNA graduates account for about one half of the middle GPA group, with a slightly larger share of OCS than ROTC graduates. As there were only 3 observations with Low GPA, this category was excluded from the analysis.

In Figure 20, SO promotion candidates with non-technical undergraduate majors and high Mathematical Qualification Codes are broken down by commissioning source. Of this population, more than half were recruited from the USNA. This may be a result of the calculus requirements in the USNA curriculum
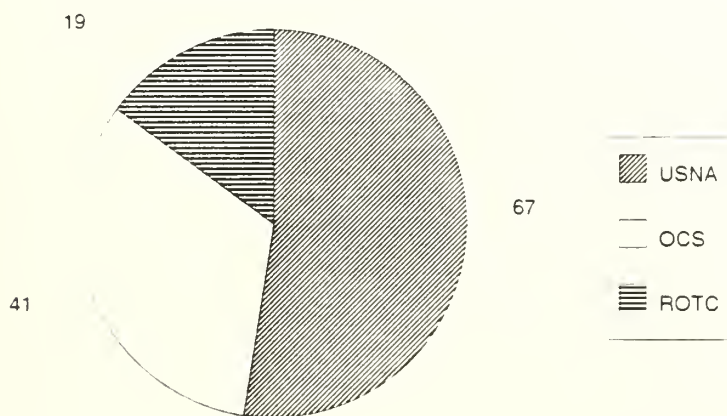
TOTAL: 127

Figure 20. SO Community Promotion Candidates with Non-Technical Undergraduate Degree and High Mathematical Qualification Code by Commissioning Source.

Figure 21 displays the SO commissioning source breakdown for individuals with non-technical undergraduate degrees and High Technical Qualification Codes Again, USNA graduates are in the majority, and this may also be attributed to requirements of the USNA curriculum (e.g. chemistry, physics).

22

59

42

USNA

OCS

ROTC
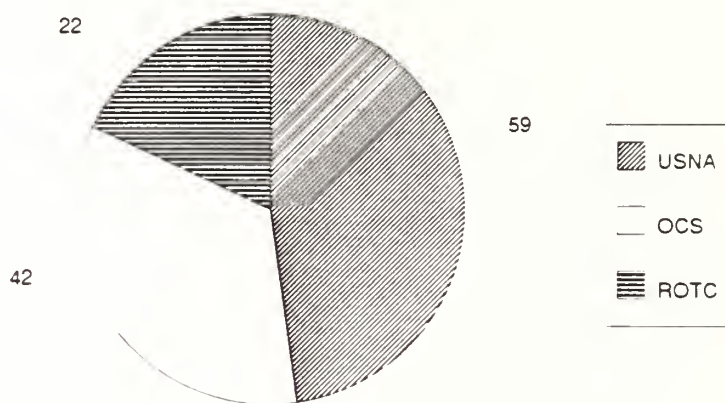
TOTAL: 123

Figure 21. SO Community Promotion Candidates with Non-Technical Undergraduate Degree and High Technical Qualification Code by Commissioning Source.

Figure 22 illustrates the breakdown of members of the SO community from the USNA and OCS with non-technical undergraduate majors and more than 12 months of prior enlisted service As one might expect, OCS graduates account for the majority of this population (more than three-quarters) Of 99 officers with more than 12 months of prior enlisted service, 85 were commissioned through OCS and only 14 were USNA graduates

14

USNA

OCS

85
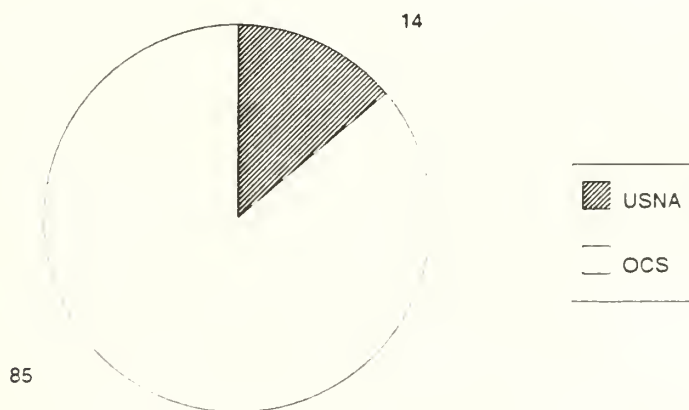
TOTAL: 99

Figure 22. SO Community Promotion Candidates with Non-Technical Undergraduate Degree and More Than 12 Months Pre-Commissioning Service by Commissioning Source.

c. Technical Major Among Promoted Officers

Further examination of the technical background issue is possible   Figure 23 shows the SOs who were promoted to O-4, broken down by commissioning source   Of the 116 selectees from OCS, 55 (47.4%) had technical degrees   One hundred fifty (81.5%) of the 184 ROTC graduates promoted to O-4 had technical degrees, and 216 (68%) of the 319 USNA officers promoted had technical degrees

184 (81.5%)   319 (68%)

USNA
OCS
ROTC

116 (47 4%)
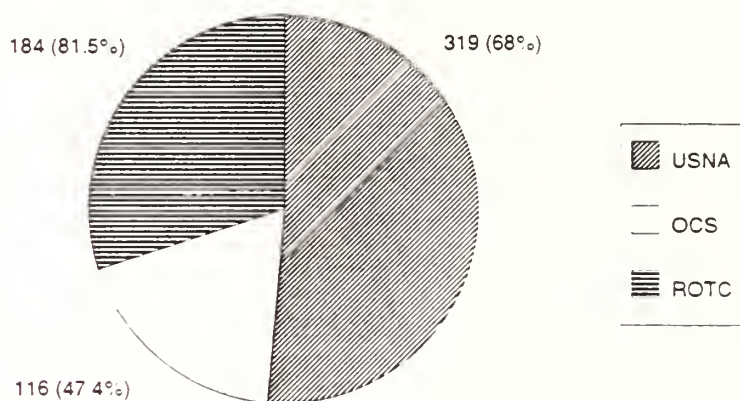
Figure 23. Number of SOs Promoted to 0-4, by Commissioning Source. (In parentheses is the percentage of officers promoted from each commissioning source who have technical undergraduate degrees.)

B.   MULTIVARIATE ANALYSIS

1. Methodology

The work of the previous section is here extended to include multivariate analysis. This will allow an examination of the effect of each background characteristic on the likelihood of promotion while holding constant all other variables. This section presents the overall results for both the SWO and Submarine communities using multivariate Logit models that were estimated by maximum likelihood techniques.

For each community, two models were constructed. The initial specification consisted of all of the relevant independent variables discussed above. In the second model, only those variables shown to be significant in the first specification were included. Additionally, the first model was run twice for each community. In the first

42

run, the model included the GRADUATE EDUCATION variable, in the second, this variable was disaggregated to distinguish between the Naval Postgraduate School and other graduate institutions.

The results are presented in tables that provide the signs and magnitudes of the estimated coefficients for the Logit models specified. The standard error of the coefficient estimates are listed in parentheses. The calculated change in probabilities associated with a one unit change in each explanatory variable is also displayed for the alternative model to aid in the interpretation of the coefficients.

2. SWO Community

a. Initial Specification

Table III displays the results of the Logit estimates for the O-4 promotion model. In spite of the fact that conventional wisdom indicates that there is no advantage to any particular commissioning source in terms of promotion likelihood, the model shows a negative effect on promotion probability for ROTC graduates, but this negative effect is statistically insignificant, so it should not be taken as a true indication of the impact of commissioning source without further investigation. One objective for further research could be to specifically investigate the impact of ROTC as a commissioning source, with a view toward accounting for the results found here. Additionally, the small negative impact of ROTC as a commissioning source is further reduced by the fact that having additional qualification designators and having been screened for command each have more of an impact on promotability than having been commissioned out of ROTC.

43

**TABLE III. LOGIT ESTIMATES OF THE SWO PROMOTION MODEL:
INITIAL SPECIFICATION**

INDEPENDENT VARIABLES	COEFFICIENT ESTIMATE[1]	COEFFICIENT ESTIMATE[2]
BLACK & OTHER	-0.286 (0.208)	-0.244 (0.208)
USNA	-0.039 (0.280)	-0.024 (0.281)
ROTC	-0.460 (0.189)*	-0.472 (0.190)*
HIGH GPA & HIGHLY SELECTIVE COLLEGE	0.142 (0.514)	0.187 (0.516)
LOW GPA & LOW SELECTIVE COLLEGE	-0.637 (0.568)	-0.555 (0.568)
HIGH MATH QUALIFICATION CODE	-0.181 (0.232)	-0.192 (0.234)
HIGH TECHNICAL QUALIFICATION CODE	0.251 (0.286)	0.249 (0.287)
MORE THAN 3 AQDs	0.961 (0.127)**	0.956 (0.128)**
AGE AT PROMOTION	-0.138 (0.031)**	-0.132 (0.031)**
NUMBER OF YEARS OF ACTIVE SERVICE	-0.341 (0.147)**	-0.328 (0.149)*
TECHNICAL UNDERGRADUATE MAJOR	-0.035 (0.157)	-0.056 (0.158)
HIGH GPA(3.2-4.0)	0.450 (0.279)***	0.485 (0.281)***
LOW GPA (0-2.19)	-0.352 (0.202)***	-0.323 (0.202)***
HIGHLY SELECTIVE COLLEGE GRADUATE	-0.111 (0.218)	-0.122 (0.219)
MARRIED AND AT LEAST TWO CHILDREN	0.402 (0.142)**	0.388 (0.143)**
LOW SELECTIVE COLLEGE GRADUATE	-0.071 (0.186)	-0.062 (0.187)
GRADUATE EDUCATION	0.946 (0.194)**	
MASTER'S AWARDED FROM NPS		1.377 (0.248)**
MASTER'S AWARDED FROM OTHER INSTITUTION		-0.165 (0.325)
SCREENED FOR COMMAND	0.898 (0.180)**	0.917 (0.181)**
INTERCEPT	7.960 (1.536)	7.673 (1.554)
CHI-SQUARE (-2 LOG LIKELIHOOD)	210.510 (P=0.0001)	224.638 (P=0.0001)
CONCORDANCE RATIO[3]	0.728	0.736
SAMPLE SIZE	1700	1700

1 INITIAL MODEL
2 MASTER'S AWARDED FROM NPS OR OTHER INSTITUTION
3 MEASURE OF THE PREDICTIVE ABILITY OF THE MODEL
( ) STANDARD ERROR IN PARENTHESES
* SIGNIFICANT AT THE .05 LEVEL
** SIGNIFICANT AT THE .01 LEVEL
*** SIGNIFICANT AT THE .10 LEVEL

From the initial model, nine explanatory variables (listed in Figure 24) are shown to be statistically significant in affecting promotion, and these are incorporated in an alternative model, the results of which are presented in Table IV. The effect of technical undergraduate major is shown to be insignificant, confirming Bowman's hypothesis that engineers do not necessarily make better SWOs

b. *Alternative Specification*

Table IV indicates that graduate education, command screening, and having a more than 3 AQDs account for the largest positive change in the probability of promotion: .163, .160, and .168, respectively.

The Logit model has a "Chi-Square" of 205.148, indicating that the model fits the data fairly well. Another measure of the prediction accuracy of this model is obtained from the concordance ratio of the Logit output. The concordance ratio measures the accuracy of the model by calculating the percentage of cases in which there is consistency between the data and the prediction. For this model the concordance ratio is .722, indicating that the data is consistent with the prediction 72.2% of the time.

Notice that when one compares the coefficients in the alternative specification with those estimated in the original specification, there are no marked changes. These coefficients are, therefore, quite robust, and increase confidence in the alternative specification.

P+

MORE THAN 3 AQDs

HIGH GPA

MARRIED, TWO CHILDREN

GRADUATE EDUCATION

SCREENED FOR COMMAND

P-

ROTC

AGE AT PROMOTION

LOW GPA

NUMBER OF YEARS
OF ACTIVE DUTY
SERVICE

Figure 24. Significant Background Characteristics for SWO Community Promotion
Candidates, Indicating Positive (P+) and Negative (P-) Influences.

TABLE IV. LOGIT ESTIMATES OF THE SWO PROMOTION MODEL: ALTERNATIVE SPECIFICATION

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	CHANGE IN PROBABILITY
ROTC .... -0.413	(0.144)**	.... -0.073
MORE THAN 3 AQDs 0.961	(0.126)**	.... 0.168
AGE AT PROMOTION .... -0.128	(0.024)**	.... -0.022
NUMBER OF YEARS OF ACTIVE SERVICE ... -0.337	(0.145)*	.... -0.058
HIGH GPA (3.2-4.0) 0.512	(0.231)*	.... 0.090
LOW GPA (0-2.19) .... -0.475	(0.182)**	.... -0.083
MARRIED, TWO CHILDREN 0.385	(0.141)**	.... 0.067
GRADUATE EDUCATION 0.931	(0.193)**	.... 0.163
SCREENED FOR COMMAND 0.912	(0.179)**	.... 0.160
INTERCEPT 7.512	(1.391)	
CHI-SQUARE (-2 LOG LIKELIHOOD) 205.148	(P=0.0001)	
CONCORDANCE RATIO¹ 0.722		
SAMPLE SIZE 1700		

1 MEASURE OF THE PREDICTIVE ABILITY OF THE MODEL
( ) STANDARD ERROR IN PARENTHESES
* SIGNIFICANT AT THE .05 LEVEL
** SIGNIFICANT AT THE .01 LEVEL

Additionally, the alternative SWO promotion model is broken down into two categories. Naval Postgraduate School education and all other education programs. The purpose of the categorization is to examine the impact of where the degree was awarded, and the results are presented in Table V. The results obtained are very similar to those of the initial specification.

**TABLE V. LOGIT ESTIMATES OF THE SWO PROMOTION MODEL:
ALTERNATIVE SPECIFICATION, SHOWING EFFECT OF WHERE DEGREE WAS
AWARDED**

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	CHANGE IN PROBABILITY
ROTC	-0.427 (0.145)"	.... -0.074
MORE THAN 3 AQDs	0.958 (0.126)"	.... 0.168
NUMBER OF YEARS OF		
ACTIVE DUTY SERVICE	-0.327 (0.147)*	.... -0.057
HIGH GPA	0.557 (0.232)*	.... 0.097
LOW GPA	-0.431 (0.183)*	.... -0.075
MARRIED AND AT LEAST TWO CHILDREN ...	0.374 (0.142)"	.... 0.065
MASTER'S AWARDED FROM NPS	1.366 (0.247)"	.... 0.239
MASTER'S AWARDED FROM OTHER		
INSTITUTION	-0.205 (0.323)	.... -0.036
AGE AT PROMOTION	-0.122 (0.025)"	.... -0.021
SCREENED FOR COMMAND	0.925 (0.180)"	.... 0.162
INTERCEPT	7.218 (1.411)	
CONCORDANCE RATIO'	0.730	

1 MEASURE OF THE PREDICTIVE ABILITY OF THE MODEL
() STANDARD ERROR IN PARENTHESES
' SIGNIFICANT AT THE .05 LEVEL
" SIGNIFICANT AT THE .01 LEVEL

Notice that the coefficient of a Master's degree from the Naval Postgraduate

School is positive and statistically significant The coefficient of OTHER INSTITUTION

is negative, but is not significant This specification indicates that attendance at NPS

increases promotion probability by 239

TABLE VI. LOGIT ESTIMATES OF THE SO PROMOTION MODEL: INITIAL SPECIFICATION

INDEPENDENT VARIABLES	COEFFICIENT ESTIMATES[1]		COEFFICIENT ESTIMATE[2]	
OCS	-0.498	(0.429)	-0.508	(0.430)
ROTC	-0.266	(0.345)	-0.275	(0.346)
HIGH GPA & HIGHLY SELECTIVE COLLEGE	0.219	(0.456)	0.224	(0.456)
HIGH MATH QUALIFICATION CODE	0.105	(0.229)	0.097	(0.229)
HIGH TECHNICAL QUALIFICATION CODE	0.320	(0.229)	0.327	(0.229)
MORE THAN 3 AQDs	1.222	(0.212)**	1.226	(0.212)**
AGE AT PROMOTION	-0.016	(0.077)	-0.016	(0.077)
NUMBER OF YEARS OF ACTIVE SERVICE	-0.392	(0.314)	-0.403	(0.315)
TECHNICAL UNDERGRADUATE MAJOR	0.239	(0.229)	0.227	(0.229)
HIGH GPA (3.2-4.0)	0.611	(0.327)***	0.606	(0.328)***
MARRIED AND AT LEAST TWO CHILDREN	0.121	(0.253)	0.119	(0.254)
HIGHLY SELECTIVE COLLEGE GRADUATE	0.135	(0.372)	0.128	(0.373)
LOW SELECTIVE COLLEGE GRADUATE	0.076	(0.375)	0.059	(0.375)
GRADUATE EDUCATION	0.260	(0.335)***		
MASTER'S FROM NPS			0.799	(0.409)*
MASTER'S FROM OTHER INSTITUTION			0.278	(0.539)
INTERCEPT	4.329	(3.228)	4.454	(3.242)
CHI-SQUARE (-2 LOG LIKELIHOOD)	76.691	(P=0.0001)	77.406	(P=0.0001)
CONCORDANCE RATIO[3]	0.731		0.732	
SAMPLE SIZE	749		749	

1 INITIAL MODEL
2 MASTER'S AWARDED FROM NPS OR OTHER INSTITUTION
3 MEASURE OF THE PREDICTIVE ABILITY OF THE MODEL
( ) STANDARD ERROR IN PARENTHESIS
* SIGNIFICANT AT THE .05 LEVEL
** SIGNIFICANT AT THE .01 LEVEL
*** SIGNIFICANT AT THE .10 LEVEL

3. SO Community

a. Initial Specification

The initial Submarine Officer community promotion model was first run with the variables listed in Table VI. The three variables with the greatest predictive capability for Submarine officer promotion to O-4 (MORE THAN 3 AQDs, HIGH GPA, and GRADUATE EDUCATION) were selected to be included in a second, alternative model.

Based on Nolan's SWO research, it is likely that warfare-specific training and high fitness reports are also positive factors in promotability of Submarine Officers [Ref. 7]. As compared to the SWO promotion model, which had nine significant variables, the Submarine Officer promotion model had four significant variables, which are indicated in Figure 25.

P+

P-

MORE THAN 3 AQDs

HIGH GPA   [NONE]

TECHNICAL UNDERGRADUATE MAJOR

GRADUATE EDUCATION

Figure 25. Significant Background Characteristics for SO Community Promotion Candidates, Indicating Positive (P+) and Negative (P-) Influences.

b. Alternative Specification

A fourth variable, TECHNICAL UNDERGRADUATE MAJOR, was also selected for the alternative specification (Table VII), although it was marginally insignificant in the initial specification. It is interesting to note that when the model was run after deleting all variables except these four, TECHNICAL UNDERGRADUATE MAJOR became significant at the .10 level.

Having more than 3 AQDs, which is a reliable indicator of expertise and prior success, results in the largest positive change in probability value, an increase of

approximately .179. It also appears that HIGH GPA, GRADUATE EDUCATION, and TECHNICAL UNDERGRADUATE MAJOR result in a .117, .096, and .051 increase in probability, respectively.

The overall fit of the model, measured using the chi-square test statistic, is 62.236, and is significant at the 0.0001 level. The overall concordance ratio is 0.662. Although the Submarine Officer community promotion model has somewhat less consistency between the data and the predictions than does the Surface Warfare community model, it still explains the data quite well. The model shows the positive effects of high GPA and graduate education on O-4 promotion competitiveness. Also, technical undergraduate major in the SO community has a positive impact on promotion in the alternative model, but in the SWO community it is statistically insignificant.

Once again, the coefficient estimates do not vary greatly between the initial and alternative specifications. So, as in the SWO model, the coefficients of the SO model can be considered robust.

TABLE VII. LOGIT ESTIMATES OF THE SO PROMOTION MODEL:
ALTERNATIVE SPECIFICATION

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	CHANGE IN PROBABILITY
MORE THAN 3 AQDs	1.246 (0.208)**	0.179
HIGH GPA (3.2-4.0)	0.815 (0.219)**	0.117
GRADUATE EDUCATION	0.667 (0.326)*	0.096
TECHNICAL UNDERGRADUATE MAJOR	0.356 (0.215)***	0.051
INTERCEPT	0.329 (0.217)	
CHI-SQUARE (-2 LOG LIKELIHOOD)	62.236 (P=0.0001)	
CONCORDANCE RATIO[1]	0 .662	
SAMPLE SIZE	749	

1 MEASURE OF THE PREDICTIVE ABILITY OF THE MODEL
( ) STANDARD ERROR IN PARENTHESES
* SIGNIFICANT AT THE .05 LEVEL
** SIGNIFICANT AT THE .01 LEVEL
*** SIGNIFICANT AT THE .10 LEVEL

V. CONCLUSIONS AND RECOMMENDATIONS

A. US NAVY PROMOTION AND RECRUITING

1. Probability For Promotion

The major conclusion of this study appears to be that promotion to O-4 can be effectively explained with a number of explanatory variables. The probability of promotion to LCDR seems to be based, in part, on an individual's performance as an officer, measured by the presence of more than 3 ADQs. Through the statistical analysis it can be concluded that among the academic background characteristics. grade point average and graduate education are important factors in attaining promotion to LCDR in both the SWO and SO communities. GPA is the most significant pre-commissioning factor. An individual with a master's degree stands a better chance of being promoted than contemporaries who do not have a master's degree. If this degree is awarded from the Naval Postgraduate School, then the promotion probability is higher. Successful completion of the master's program is another indicator to the Navy that an individual has the potential for future service and greater responsibility.

The technical undergraduate major does not have an effect on the probability of being promoted in the SWO community; but it does have an effect in the SO community, although in the latter case it is less significant than GPA and graduate education.

2. Applying Promotion Statistics In Recruiting

The results of this study provide possibilities for further policy use or further study. First, since it appears that technical degrees have in reality little impact on the success of a SWO, the recruiting effort should be aimed at recruiting the more well-rounded individual to fill the billets of surface warriors. Further research in this area could lead the Navy to determining what type of education is the best suited for success as a SWO. The second policy implication lies in what is being taught to the midshipmen who are commissioned through the ROTC units. This study indicates that SWOs joining the Navy from ROTC sources are less likely to be promoted than those accessed from OCS. The coefficient, however, was only marginally statistically significant. One needs to understand whether this is an indication that those within the ROTC program are less well prepared for Navy Service, or whether it is a result of the more extensive previous service in the enlisted ranks of the graduates of the OCS programs. Another policy implication that can be drawn from this study is that the officers who show the potential for advancement and who are sent to the Naval Postgraduate School continue to be among the Navy's top performers and stand a better chance of being promoted than their counterparts who do not attend the Naval Postgraduate School. The process of selection to the program is still valid for picking those who will succeed in the Navy.

B.   IMPLICATIONS FOR THE ROK NAVY

1. Potential For Use

As stated in Chapter I, the ROK Navy continues to attract top quality men and women capable of operating the high technology equipment and weapons systems necessary to keep up with geo-political changes on the Korean peninsula With the introduction of submarines into its Navy, and the emphasis on high technology ships in general, recent changes may present problems for the Navy in terms of its ability to continually meet its personnel needs The Navy must address two types of needs in the short term, the need is to attract a sufficient number of applicants for the Submarine and SWO programs; and in the long term, it is to prepare for a possible shortfall of line officers Both short term and long term, the opportunities for recruiting officer candidates lie in both the civilian and military communities The Navy must be competitive with civilian employers and educational institutions in order to attract quality college graduates and high school students in senior years who will choose between entering civilian colleges and service academies.

Clearly implicit in these goals is the need to upgrade the overall image of the ROK Navy as a profession, and thus make the Navy a more generally attractive and competitive alternative. From a manpower recruiter's prospective, the Navy has good opportunities to recruit qualified candidates for service The employment rate in 1993 for recent college graduates was 60.2 percent, a drop of 3.2 percent as compared to 1992 [Ref. 9] Competition from civilian employers is much greater for officers than for

enlisted men, because the vast majority of young college graduates expect to work in a professional or managerial capacity, and the image of the Navy does not meet those expectations (this is just as true for the Army and Air Force) Competition will occur in two primary areas the more immediately available college graduates whose interest is in technically-oriented jobs or who have a high GPA, and among high school students choosing between college or service academies

To most effectively recruit for the Submarine Officer community, the ROK Navy should consistently direct its efforts at attracting technically-oriented college graduates Another possibility would be to provide increased opportunities for funded postgraduate studies in order to expand the potential pool of Navy officer candidates Additionally, an effort to upgrade the Navy's image would assist in attracting qualified high school seniors who could be persuaded to major in Submarine and Surface Warfare related fields, thus providing a pipeline of officer candidates for the future.

2. Implementation

Based upon the results of this work, the following recommendations are made

1. The ROK Navy should conduct a study to determine which background characteristics indicate a high probability of promotion in its Surface Warfare Officer community (a study similar to the one undertaken in this work)

2. If the results of a study of the ROK SWO community indicate a correlation between the background characteristics of promotion candidates in the two countries, assumptions may be made about the likely characteristics of promotable

Submarine Officers in the new ROK Submarine Officer community. In other words, barring any significant deviation in the ROK SWO community background characteristics, the ROK SO community can be expected to differ from the SWO community in a manner similar to the differences between the two communities in the US.

3. Based upon the outcome of (2) above, the ROK Navy should develop and employ strategies to focus recruiting efforts on individuals who exhibit background characteristics that will most likely lead to promotion.

4. The recently planned acquisition of submarines for the ROK Navy presents manpower specialists with the opportunity to launch a pilot program to determine the efficacy of a recruiting effort focused on background characteristics exhibited by promotable officers

5. Subsequent promotion rates should provide indications as to whether or not predictions are accurate. If the analysis of background characteristics is indeed accurate, the ROK Navy can do similar studies and strategies for other officer communities, such as Naval Aviators.

APPENDIX A. DESCRIPTION OF VARIABLES FOR O-4 PROMOTION MODEL

VARIABLE   DESCRIPTION

RACE   = 1 If the observation is non-white
           = 0 If the observation is white
ACADEMY   = 1 If the observation is a USNA graduate
           = 0 If the observation is not a USNA graduate
ROTC   = 1 If the observation is commissioned by ROTC
           = 0 If the observation isn't commissioned by ROTC
OCS   = 1 If the observation is commissioned by OCS
           = 0 If the observation isn't commissioned by OCS
AAGE   = Continuous variable equal to the observation's age at promotion
LOS   = Continuous variable equal to the number of years of active duty service
TECHDEG   = 1 If undergraduate degree is Engineering, Mathematics, Physics,
             Computer Science
           = 0 Otherwise
HIGH GPA   = 1 If undergraduate Grade Point Average is 3.2-4 0
           = 0 Otherwise
LOW GPA   = 1 If undergraduate Grade Point Average is less than 2 2
           = 0 Otherwise
FAMILY   = 1 If the observation is married, and has one or two children
           = 0 If the observation has no dependents
CMDSCRN   = 1 If observation screened for command
           = 0 If observation did not screen for command
ADDQUAL   = 1 If observation has 4 or more additional qualification designators
           = 0 If observation has 3 or less additional qualification designators
GRADUATE   = 1 If observation has Master's Degree
           = 0 If observation does not have Master's Degree
NPS   = 1 If observation granted Master's from NPS
           = 0 If observation granted Master's from other institution
GRADDEG   = 1 If observation granted Master's from other institution
           = 0 If observation granted Master's from NPS
HSELECT   = 1 If observation is highly selective college graduate
           = 0 Otherwise
LSELECT   = 1 If observation is low selective college graduate
           = 0 Otherwise
TECHQUAL   = 1 If observation includes pertinent upper-division technical courses with

58

	an average of B+ or higher
	= 0 Otherwise
MATH	= 1 If observation signifies significant post-calculus math with grades of B
	or higher or completion of a calculus course sequence with a B+ or better
	= 0 Otherwise
SUPER	= 1 If observation is HIGH GPA and highly selective college graduate
	= 0 Otherwise
POOR	= 1 If observation is LOW GPA and low selective college graduate
	= 0 Otherwise

APPENDIX B. OFFICER RECRUIT QUALIFICATIONS FOR SO COMMUNITY[REF. 10]

- Qualifications in General

  - Qualified recruits are college graduates with credentials in science, engineering, mathematics, oceanography, computer science or computer applications and potential to organize and direct the work of others in confined spaces for extended periods at sea Good vision and normal color perception are physical requirements special to this field

- Gender

  - Male only

- Citizenship

  - United States citizen

- Age

  - Older than 18 years and younger than 26 years, 6 months at time of commissioning

- Security

  - Eligible for access to classified information before appointment, based on a background investigation

- Volition

  - Bona-fide volunteer for sea duty in submarines

- Education -- Meet all five of the following requirements

  - One year of college calculus-based physics covering the classic fundamentals of mechanics, magnetism and electricity with a "B" average or better
  - One year of college calculus through differential and real calculus of one real variable with a "B" average or better
  - Academic major in mathematics, physics, chemistry or an engineering curriculum
  - "B" average or better in technical and science courses
  - Baccalaureate degree from an accredited college or university with a graduation grade average of 3.3 or higher

- Aptitude

  - Officer Aptitude Rating Test score of 40 or higher.

- Physical

  - Recruits meet the physical standards for commissioning established by Commander, Naval Medical Command in the Manual of the Medical Department (MANMED), Chapter 15. They also have: normal color vision and depth perception, distant vision correctable to 20/20 with lens, refractive error not to exceed +-3.00 diopters; normal hearing in both ears with demonstrated ability to equalize pressure

LIST OF REFERENCES

1   Bowman, W. R., "College Education, Job Turnover and Work Performance for the Military in the 21st Century," Prepared for the Thirty-Third International Atlantic Economic Conference, French Riviera, April 6. Annapolis, MD, United States Naval Academy, Department of Economics, 1990.

2   Goldberg, Lawrence, *Enlisted Supply: Past, Present and Future*, Center for Naval Analysis, September 19-20, 1982

3   Bowman, W. R., "Do Engineers Make Better Naval Officers?,"*Armed Forces & Society* Vol. 16 (winter), 1991.

4   Bowman, W. R., "Are Service Academies Worth The Cost?,"*Recent Findings for Surface Warfare and Pilot Communities*, Prepared for the IUS Biennial Conference, Baltimore, MD, October 11-13, 1992

5   Foster, Michael J., "An Analysis of The Relative Productivity of Officers from Different Accession Sources," Master's Thesis, Naval Postgraduate School, Monterey,CA, 1991

6   Cymrot, Donald J., *Graduate Education and The Promotion of Officers*, Center for Naval Analysis March 1986

7   Nolan, Joseph F., "An Analysis of Surface Warfare Officer Measures of Effectiveness As Related to Commissioning Source, Undergraduate Education, and Navy Training," Master's Thesis, Naval Postgraduate School, Monterey, CA, 1991.

8   *Barron's Profiles of American Colleges*, Barron's Educational Series, Inc., New York, Barron's Educational Series, Inc., 1991.

9   *The Korean Daily Newspaper*, August 3, 1993

10 *Officer Recruit Qualifications*, Commander, Navy Recruiting Command (Code 222E), 15 Jun. 1993.

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center   2
   Cameron Station
   Alexandria, VA 22304-6145

2. Library, Code 52   2
   Naval Postgraduate School
   Monterey, CA 93943-5000

3. Dr Gregory G Hildebrandt   2
   Code AS/HI
   Department of Administrative Sciences
   Naval Postgraduate School
   Monterey, CA 93943-5002

4. LCDR Carol Mitchell   2
   Code AS/MI
   Department of Administrative Sciences
   Naval Postgraduate School
   Monterey, CA 93943-5002

5. Office of the Naval Attache   1
   Embassy of the Republic of Korea
   2450 Massachusetts Ave NW
   Washington, DC 20008

6. Choong Nam Province Non San Gun Du Ma Myeon Bu Nam Ri   2
   Sa Seo Ham 201
   Office of Education
   ROK Naval Headquarters
   320-919

7. LT Woo Young Saw   2
   Jeon Buk Province Ok Ku Kun Dae Ya Myeon
   Ji Gyung Ri
   766-13
   Seoul, Korea

GAYLORD S